1.0 HOUR

CME/CE Clinical Précis
for the Interprofessional Health Care Team

Hip Fractures: Which Interventions Are Effective For Managing Pain?

R Sean Morrison, MD, FAAHPM
Director, National Palliative Care Research Center
Director, Hertzberg Palliative Care Institute
Hermann Merkin Professor of Palliative Care
Professor of Geriatrics and Medicine
Brookdale Department of Geriatrics and Palliative Medicine
Mount Sinai School of Medicine
New York, NY
Disclosures: Nothing to disclose

Lisa M Balfe, MPH
Medical Writer
PRIME Education, Inc. (PRIME®)
Tamarac, FL

Release Date: March 31, 2012

Expiration Date: March 31, 2014

There is no fee for this CME/CE activity. This activity is sponsored by PRIME Education, Inc (PRIME®) and funded under contract HHSA290201000006G from the Agency for Healthcare Research and Quality (AHRQ), U.S. Department of Health and Human Services (HHS).

For additional copies of this Clinical Précis visit www.ce.effectivehealthcare.ahrq.gov

Contributing Authors

R Sean Morrison, MD, FAAHPM
Director, National Palliative Care Research Center
Director, Hertzberg Palliative Care Institute
Hermann Merkin Professor of Palliative Care
Professor of Geriatrics and Medicine
Brookdale Department of Geriatrics and Palliative Medicine
Mount Sinai School of Medicine
New York, NY
Disclosures: Nothing to disclose

Lisa M Balfe, MPH
Medical Writer
PRIME Education, Inc. (PRIME®)
Tamarac, FL
Disclosures: Nothing to disclose

This is a 1.0 hour CE activity designed to meet the educational needs of physicians, physician assistants, nurse practitioners, nurses, case managers, and health education specialists. Please review the accreditation information on page 17 before you start this activity.

Hip Fractures: Which Interventions Are Effective For Managing Pain?

Learning Objectives

Based on the findings from AHRQ's comparative effectiveness review on management strategies for women with noncyclic chronic pelvic pain:

1. Compare the efficacy and safety of interventions for controlling acute and chronic pain related to hip fractures
2. Summarize the effectiveness of pain interventions on mortality, functional status, health-related quality of life, and health services utilization
3. Determine the safety and efficacy of pain interventions among specific patient subpopulations
4. Apply the systematic review findings to educate patients about treatment options for pain management following hip fractures

Background and Public Health Burden of Hip Fractures

Hip fractures are a significant public health issue, leading to substantial rates of morbidity and mortality. The incidence of hip fractures ranges from 22.5 and 23.9 per 100,000 men and women, respectively. By age 80, these ranges increase to 630.2 and 1,289.[3] for men and women, respectively.[1-4] With short-term mortality rates ranging from 25 percent for women to 37 percent for men during the first year following the fracture, the health impact can be devastating. Approximately 25 percent to 50 percent of older adults with hip fractures do not return to their pre-fracture level of function until 6 months after the injury occurred. This poor functional recovery contributes to a high utilization of health resources and increasing health care costs.

Hip fractures are also associated with severe pain, which can lead to delirium, depression, sleep disturbance, and decreased response to interventions for other comorbidities.[5-7] As a result, the consequences of poorly managed postoperative pain can further complicate treatment and recovery. Acute treatment of pain is necessary, since poor management is associated with delayed ambulation, pulmonary complications, and delays in patient transitions to different levels of care.[8]

Interventions intended to alleviate pain are divided according to the timing of the operation and include: pre-, peri-, and postoperative. Preoperative

interventions traditionally use systemic analgesia. Nerve blocks, which incorporate the use of analgesics to block nerve impulses from reaching the sensory cortex, have recently been introduced as a mechanism to alleviate pain. Intraoperative interventions typically incorporate general anesthesia and systemic analgesia. Neuraxial anesthesia has been commonly used as a substitute for general anesthesia. Postoperative pain management entails the use of a multitude of interventions including systemic analgesia, nerve blocks, physical therapy, and transcutaneous electrical nerve stimulation (TENS). Combined approaches that are used to disrupt pain by different mechanisms are known as "multimodal" pain management.

AHRQ's Comparative Effectiveness Review

In an effort to synthesize information from studies comparing the efficacy of interventions used to treat pain associated with hip fractures, the Agency for Healthcare Research and Quality (AHRQ) commissioned a comparative effectiveness review which was published in May 2011.[9] A preliminary review was conducted by the University of Alberta Evidence-based Practice Center (UAEPC) in order to determine the quantity of available evidence and to draft key questions for the comparative effectiveness review (CER). AHRQ and the Scientific Resource Center invited a technical expert panel (TEP) to provide input in the development of key questions for the report. After public commentary, the finalized key questions were sent to AHRQ for approval. The clinical study literature was summarized and reviewed using the PICOTS (population, intervention, comparison, outcome, timing, and setting) framework. Evidence identified from these outcomes was examined in detail to determine the strength of evidence of the studies. The key questions were developed according to the criteria listed below:

- **P**opulation: Elderly patients experiencing pain due to non-pathological, low-impact injury hip fractures
- **I**nterventions: Pain management methods, including systemic analgesia, neuraxial anesthesia, nerve blocks, traction, TENS, rehabilitation, complementary and alternative methods, and multimodal approaches
- **C**omparators: usual care (nonopioid and opioid systemic analgesia) and/or other interventions
- **O**utcomes: pain intensity, mental status, 30-day mortality, and serious adverse events (stroke, myocardial infarction, renal failure)
- **T**iming: acute care, within 30 days of fracture
- **S**etting: acute care

Process for Conducting the Review

Topics for the review were nominated through an open public process, which included submissions from professional organizations, policymakers, health care professionals, and the private sector. Investigators at the UAEPC in Edmonton, Alberta, Canada researched databases including MEDLINE, Cochrane Central Register of Controlled Trials, and Cumulative Index to Nursing and Allied Health Literature, including studies published from 1990 to 2010. The reviewers also searched medical journals, relevant reviews, and literature from scientific meetings and public clinical trial registries. The quality of the studies was evaluated by 2 independent reviewers with criteria including the extent of treatment blinding, description of the randomization procedure, adequate control of potential confounders or bias, appropriate methods for addressing incomplete outcome data, and whether funding sources and conflicts of interest were identified. Findings from the literature search are illustrated in Table1.

The strength of evidence was classified into 4 main categories which are detailed in *AHRQ's Methods Guide for Effectiveness and Comparative Effectiveness Reviews.*[10] To evaluate the evidence, the GRADE (Grading of Recommendations Assessment, Development, and Evaluation) working group developed an instrument that

Table 1. Pain Management Interventions for Hip Fracture Included in the AHRQ Review

Intervention	Studies (N)	Timing
Systemic analgesia	3	Pre- and postoperative
Anesthesia	30	Intraoperative
Nerve Blocks	32	Pre-, intra-, and postoperative
Traction	11	Preoperative
TENS	2	Pre- and postoperative
CAM interventions	2	Preoperative
Rehabilitation	1	Postoperative
Multimodal management	2	Pre- and postoperative

Source: Derived from Abou-Setta AM, Beaupre LA, Jones CA, et al. Pain Management Interventions for Hip Fracture. Comparative Effectiveness Review No. 30. Rockville, MD. Agency for Healthcare Research and Quality. May 2011. Available at: http://www.effectivehealthcare.ahrq.gov/ehc/products/95/678/CER30__FinalReview_20110517.pdf.

considers factors such as directness, precision, consistency across studies of the same and different designs, magnitude of effect, applicability, and the potential for publication bias. The evidence was graded as *high*, *moderate*, *low*, or *insufficient*. The first 3 of these grades indicate the investigators' confidence in the extent to which the evidence reflects true, or systematic, treatment effects. A grade of *insufficient* indicates that evidence does not either exist or permit the estimation of effects.

Summary of Key Questions

The UAEPC investigators based their comparative effectiveness review on 4 main questions. The key questions, which are summarized below, compared usual (standard care) with other pain management interventions for older adults (≥ 50 years) admitted to the hospital following a hip fracture.

QUESTION 1

- What are the comparative effects of various pharmacological and nonpharmacological pain management interventions on acute and chronic pain?

This question focuses on the primary outcomes of interest.

QUESTION 2

- What are the comparative effects of various pharmacological and nonpharmacological pain management interventions on secondary outcomes?

Secondary outcomes of interest included 30-day mortality, length of hospitalization, delirium associated with pain, additional pain medication use, quality of sleep, and health-related quality of life.

QUESTION 3

- What are the comparative adverse effects associated with different pain management interventions?

Adverse events included gastrointestinal disturbance, headaches, infection, allergic reaction, bradycardia, nausea or vomiting, neurologic complications, myocardial infarction, stroke, sensory deficits or motor weakness, pulmonary embolism, and deep venous thrombosis.

QUESTION 4

- How do the effectiveness and safety of pain management interventions vary in different subpopulations?

Pain Management Interventions Overview

Interventions targeting the pain associated with hip fractures can be divided into pharmacological and nonpharmacological treatment therapies. Systemic analgesia, medications used in nerve blocks, and neuraxial anesthesia are examples of pharmacological interventions. TENS, acupressure, and fracture stabilization via traction are nonpharmacologic pain interventions.

The choice of pain management interventions are guided by prior medical status of the patient, fracture characteristics, and requirements of the treatment plan. Comorbidities can also affect the perception of pain and response to pain treatment. Usual care for pain following a hip fracture includes systemic analgesia, primarily using nonsteroidal anti-inflammatory drugs (NSAIDs) and opioids. However, complications associated with opioid use can include altered mental status changes, nausea and vomiting, respiratory depression, and constipation. Similarly, NSAID side effects of gastrointestinal bleeding and renal toxicity are particularly problematic in older adults. Accordingly, AHRQ sought to determine which alternative methods could be effective and safe for pain management in older adults with hip fracture.

Comparative Effectiveness of Interventions for Acute Pain Relief

With a total of 83 studies included in the review, consisting of 64 randomized controlled trials (RCTs), 5 nonrandomized controlled trials (nRCTs), and 14 cohort studies, the participants were predominantly females older than 75 years of age without cognitive impairment. The cohort studies were generally of moderate quality, while many trials were low quality with a high or unclear risk of bias. Peri- and postoperative management of pain and reported morality and adverse events associated with the interventions were evaluated. There were no studies that addressed long-term pain, and other outcomes including bradycardia, neurologic complications, myocardial infarction, stroke, sensory deficits or motor weakness, pulmonary embolism, and deep venous thrombosis were rarely reported.

Overall, nerve blocks were proven to be effective at relieving acute pain. Most studies did not indicate whether or not nerve blocks affected rehabilitation, including ambulance or mobility, if sensory or motor effects were present. Potential reductions in acute pain were found for acupressure, relaxation therapy, and TENS; however, further evidence is needed to fully determine the effects of these interventions. Postoperative physical therapy showed some evidence for improvements in pain status, but the quality of the evidence was insufficient. Parecoxib, a systemic analgesic not available for use in North America, showed some potential as a possible alternative

to NSAIDs and intramuscular opioid injections. Preoperative traction and spinal anesthesia were not consistently effective at improving pain status when compared with standard care.

Take-Home Messages: Comparative Effectiveness of Pain Management Interventions for Hip Fractures in Older Adults

Nerve Blocks:

- Reduce the intensity of acute pain (3-in-1, fascia iliaca, femoral, psoas compartment, and combined obturator and femoral blocks) ■■
- Decrease the incidence of delirium ■■
- Are equally effective compared to spinal anesthesia for acute pain relief (psoas compartment, posterior lumbar plexus, and combined lumbar and sacral plexus blocks) ■

Skin Traction:

- Does not reduce the intensity of acute pain ■

Rehabilitation, Acupressure, Relaxation Therapy, TENS:

- Evidence for pain relief was insufficient to reach firm conclusions for pain relief

■■ = Medium strength of evidence
■ = Low strength of evidence

Measuring Pain Levels

Self-reported pain is the "gold standard" for measuring the character and intensity of pain.[5] The presence of dementia or delirium – found in a large proportion of patients with hip fracture - may interfere considerably with a patient's ability to self-report pain and complicates pain assessment and management.[11-14]

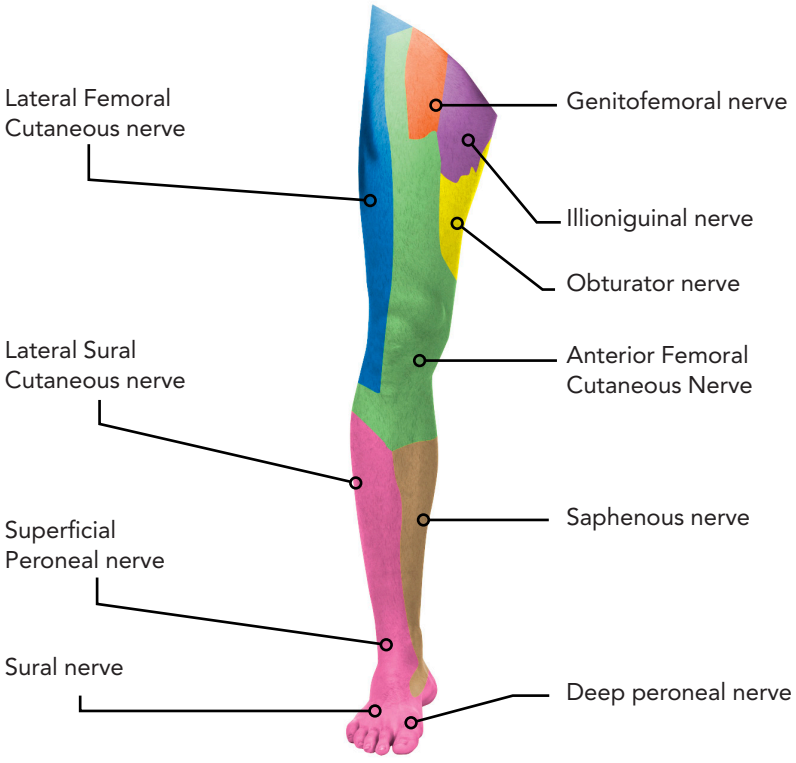
The Visual Analogue Scale (VAS), the most commonly used instrument to measure pain levels in research studies, consists of a 100 mm unmarked line with "no pain" on the far left and "worst pain ever" on the far right. Respondents point to or mark a line on the scale that indicates how much pain they are feeling. Whereas results of the the VAS are highly reliable, valid, and allow scaling of the magnitude of pain intensity, they are relatively difficult for patients to understand – particularly in the setting of mild cognitive impairment – and are not widely used in routine clinical practice.

Other more common tools used to measure pain in the clinical setting include numeric rating scales, verbal descriptive scales, and pictorial or cartoon scales. Numeric scales, which generally have numbers between 0 and 10, are used to rate how much pain the patient is currently feeling, with higher numbers indicating a greater pain intensity. The widely accepted range for clinically significant absolute pain reduction is 20 percent to 30 percent (2-3 points on a ten point scale), which corresponds approximately to a 30 mm of absolute difference on the VAS.

Nerve Blocks for Acute Pain

There are various types of nerve blockades used to manage pain for the hip fracture patient including the femoral, 3-in-1 (femoral, obturator, and sciatic nerves), fascia iliaca, psoas (lumbar plexus), and continuous epidural. The nerves targeted in the different nerve block interventions are depicted in Figure 1. Local anesthetics such as bupivacaine are used in regional nerve blocks to prevent the conduction of pain signals to the central nervous system (CNS). Clonidine, morphine,

Figure 1: Nerves Targeted for Nerve Blockade Intervention



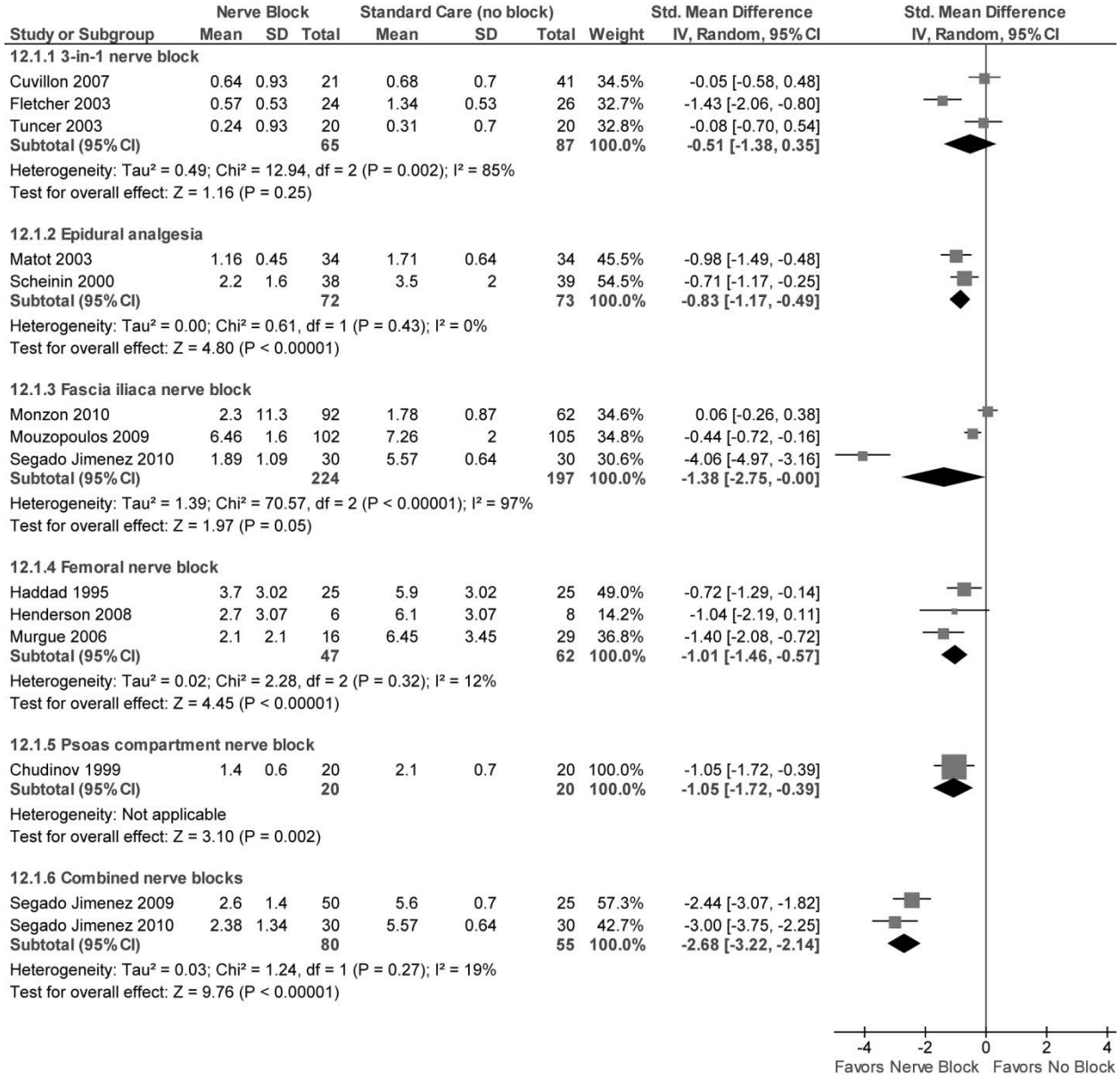
Used with permission from www.nysora.com.

fentanyl, and sufentanil are additional medications commonly used in nerve blocks.

Post-treatment acute pain was reported in 13 RCTs[15-27] which are depicted in Figure 2. In 1 RCT,[28] a statistically significant difference in the frequency of postoperative pain on the first day was found in favor of nerve blocks compared with no nerve block (7/25 vs 20/25; odds ratio [OR]=0.10; 95 percent confidence interval [CI] = 0.03 to 0.36; *P*=.0005). Four trials reported pain on movement,[18-20,27] but the heterogeneity among the studies prevented the completion of a meta-analysis of pooled results from the studies. Pooled results from 2 RCTs[20,26] found significant reductions in pain favoring the 3-in-1 nerve block over no block (standardize mean difference [SMD] = -1.02; 95 percent CI = -1.83 to -0.21; *P*=.01). Another RCT[20], which had a high risk for bias, found significant improvements in pain relief on the 10 cm VAS favoring nerve blocks using preoperative epidural analgesia over no nerve block (MD=-2.30; 95 percent CI = -2.92 to -1.68; *P*<.00001). Results from 1 RCT[29] found no significant differences in pain relief for femoral nerve blocks compared with no nerve block when using the 5-point Verbal Rating Scale.

Three RCTs,[19,26,29] with a moderate strength of evidence, reported post-

Figure 2. Systemic Analgesics and Anesthesia Interventions and Mechanisms of Action



Derived from Abou-Setta AM, Beaupre LA, Jones CA, et al. Pain Management Interventions for Hip Fracture. Comparative Effectiveness Review No. 30. Rockville, MD. Agency for Healthcare Research and Quality. May 2011. Available at: http://www.effectivehealthcare.ahrq.gov/ehc/products/95/678/CER30__FinalReview_20110517.pdf.

treatment pain on rest for nerve block interventions. Compared with standard care, postoperative 3-in-1 nerve blocks did not lead to significant differences in pain relief on the 10 cm VAS.[26] However, another RCT[19] with a high risk for bias found a statistically significant difference in pain relief favoring nerve blocks over standard care according to the 10 cm VAS (MD = -0.55; 95 percent CI = -0.81 to -0.29; *P*<.0001). Similarly, femoral nerve blocks were significantly favored over standard care for relief of pain on rest using the 5-point Verbal Rating Scale (MD = 0.18; 95 percent CI = 0.03 to 0.33) *P*=.02). In 3 RCTs evaluating nerve block compared with neuraxial anesthesia,[26,30,31] no statistically significant differences were found for acute pain relief between the 2 groups (MD = -0.35; 95 percent CI = 1.10 to 0.39; *P*=.35).

According to studies included in the AHRQ review, most nerve blocks were able to reduce the intensity of acute pain and the incidence of delirium with a moderate strength of evidence. A low strength of evidence indicated that most do not reduce the risk of 30-day mortality; however the studies were not statistically powered to truly reflect the effects on mortality outcomes.

Comparisons of Systemic Analgesics for Acute Pain

The efficacy and harms associated with various systemic analgesics were evaluated in 3 RCTs involving 214 participants, with sample sizes ranging from 30 to 94.[32-34] Acute pain was measured on the 10 cm VAS scale, with a mean baseline of 6.5 cm. There was an unclear risk of bias in all studies, and the evidence was insufficient to permit the estimation of the comparative effects of systemic analgesics for the relief of acute pain. Parenteral analgesics (parecoxib intravenous (IV) vs diclofenac ± meperidine intramuscular (IM), and intrathecal isotonic clonidine vs intrathecal hypertonic clonidine) were compared in 2 studies.[32, 33] Parecoxib IV was favored over diclofenac ± meperidine IM (MD = -0.70; 95 percent CI = -1.04 to -0.36; *P*<.0001); however, this finding was not clinically significant.[32]

A statistically significant, although not clinically significant, difference in acute pain relief favoring isotonic clonidine compared with intrathecal hypertonic clonidine post-treatment (MD=-1.69; 95 percent CI = -2.01 to -1.37; *P*<.00001).[33] Another RCT[34] comparing the oral analgesics, lysine clonixinate with metamizole, did not find a statistically significant difference in pain relief (MD = -0.43; 95 percent CI = -1.30 to 0.44; *P*=.33). Of note, none of the agents tested in any of these trials are commonly used in clinical practice and indeed, because of its toxic metabolite normaperidine, meperidine should never be used for analgesia in older adults.

Comparisons of Anesthesia for Acute Pain

The comparative efficacy and harms of neuraxial anesthesia, including continuous or single administration spinal or epidural anesthesia, was evaluated in 21 RCTs[35-54] and 1 nRCT.[55] These trials included a total of 1,062 participants ranging in sample size from 20 to 90. Results from 8 cohort studies[56-63] comparing spinal anesthesia with general anesthesia or other modes of administration of spinal anesthesia was also included in the review, and included a total of 3,086 participants, most of whom were female, and sample sizes ranging from 25 to 1,333. The mean age of participants was between 69.8 and 86.0 years. Acute pain levels were measured on the 10 cm VAS with an average baseline score of 4.7 cm.

In 1 RCT, spinal anesthesia was favored over general anesthesia for the relief of acute pain (MD = -0.86; 95 percent CI = -1.30 to -0.42; *P*=.0001); however, this finding was not considered to be clinically significant. Three RCTs compared standard spinal anesthesia with the addition of clonidine, fentanyl, meperidine, morphine, or sufentanil for post-treatment pain relief. Among patients receiving additional fentanyl or sufentanil, none reported pain following the procedure.[51,64] In addition, no significant difference in pain relief was found in a study[45] comparing additional morphine with standard spinal anesthesia (MD = -0.36; 95 percent CI = -1.11 to 0.39; *P*=.35).

Transcutaneous Electrical Neurostimulation (TENS)

TENS includes the application of electrodes with varying amplitudes and frequencies to peripheral nerves in the affected area.[65] Pooled results from 2 RCTs found significantly greater pain relief for patients receiving TENS therapy compared with sham control (MD = -2.79; 95 percent CI = -4.95 to -0.64; *P*=.01); however, these results were not clinically significant.[66,67] In 1 trial reporting pain on movement,[66] significantly greater improvements in pain relief were found for neurostimulation compared with sham control (MD = -3.90; 95 percent CI = -6.22 to -1.58; *P*=.001).

Skin and Skeletal Traction

Once considered an effective treatment modality, skin and skeletal traction are no longer commonly used for the treatment of hip fracture pain. Traditionally, preoperative or skeletal traction was standard care for the hip fracture patient population. The theory was that traction could diminish pain by stabilizing the hip joint and leg, and decrease intracapsular joint pressure.[9] A

Cochrane systematic review consisting of 10 randomized controlled trials (1,456 participants) noted no benefits for traction.[68] Skin traction involves bandaging the limb with adhesive tape and attaching a traction sled with weight hung from it.[69,70] In skeletal traction, pins are inserted into the proximal tibia or distal femur while the patient is under local anesthesia, and weights and ropes are then attached to the pins.[69] Skin traction, skeletal traction, and no traction were compared in 8 trials[54,71-77] which found no significant differences among the groups for the reduction of acute pain. However, the strength of evidence for these results was rated as low.

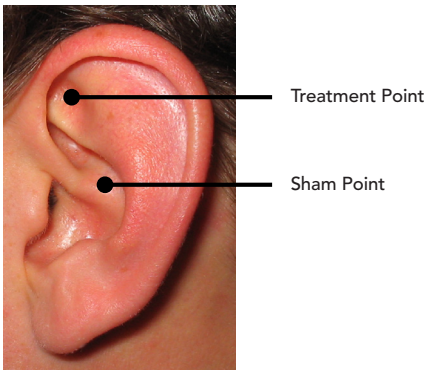
Rehabilitation for Acute Pain

Rehabilitation is a standard approach to postoperative care for patients with hip fractures. Rehabilitation often includes physical therapy and functions to stretch and strengthen the spinal and psoas muscles. Ultimately, the goal of rehabilitation is to increase muscle strength and range of joint motion; however, delirium and pain may limit patient participation.[9] A statistically significant difference in pain relief was noted in 1 RCT[78] comparing physical therapy with standard care (MD = -1.39; 95 percent CI = 2.27 to -0.51; *P*=.002); however, these results were not clinically significant.

Complementary and Alternative Medicine (CAM)

Complementary and alternative medicine techniques include auricular acupressure and Jacobsen relaxation. In auricular acupressure, tiny beads are placed on the outer ear at acupuncture points corresponding to the hip.[79] This is believed to enhance the flow of chi, or life energy, and has a systemic analgesic effect. Acute pain for auricular acupressure was measured on the 10 cm VAS scale. Jacobsen relaxation, a 2-step process involving the relaxation and contraction of muscles, measured acute pain on the 10-point verbal Sensation of Pain and Distress Scale.[79]

Figure 3. Acupressure vs Sham Control



Source: Kober A, Scheck T, Greher M, et al. Anesth Analg. 2002;95(3):723-7.

In 1 RCT,[81] acupressure was found to reduce pain compared with a sham intervention (MD = -3.01; 95 percent CI = -4.53 to 1.49; *P*<.0001). Greater reductions in acute pain were also found for relaxation compared with no relaxation (MD = -1.10; 95 percent CI = -1.43 to -0.77; *P*<.00001); however, this result was not clinically significant.[80] The overall evidence for CAM interventions was insufficient to make firm conclusions.

Comparative Effects of Pain Interventions on Secondary Outcomes

The review synthesized literature on secondary outcomes including 30-day mortality, delirium associated with pain, length of hospitalization, additional pain medication use, quality of sleep, and health-related quality of life. Patients treated with nerve blocks compared to usual care had a lower risk of cardiovascular mortality; however, these results were nonsignificant. A moderate strength of evidence also favored nerve blocks over usual care for reducing the incidence of delirium.

30-day Mortality

Comparisons of general or spinal anesthesia with epidural anesthesia yielded insufficient evidence to draw firm conclusions regarding the comparative efficacy of these interventions on 30-day mortality outcomes. No significant differences in mortality rates were found in 2 RCTs[43,82] comparing spinal anesthesia with general anesthesia (10/53 vs 5/46; OR = 1.73; 95 percent CI = 0.53 to 5.68; *P*=.36). In a review of 5 cohort studies,[56,59,60,62,63] no significant differences in mortality rates were found for spinal anesthesia compared with general anesthesia, although participants receiving continuous spinal anesthesia had lower mortality rates (70/1077 vs 113/1673; OR = 1.08; 95 percent CI = 0.58 to 2.01; *P*=.80). No significant differences in mortality rates were found in the subgroup analysis of single dose spinal anesthesia versus general anesthesia.

1-year Mortality

The literature on 1-year mortality rates and long-term outcomes after hospital discharge are sparse. Two RCTs with 112 participants[16,17] and 1 retrospective cohort study of 535 participants[83] found no significant differences in mortality between nerve blocks and standard care for 1-year mortality.

Delirium

Delirium, a dangerous complication associated with hip fractures, was studied as a secondary outcome of interest. Reported in 1 RCT[34] comparing lysine clonixinate with metamizole, the incidence of delirium was not found to be significantly different between the 2 groups OR = 0.96; 95 percent CI = 0.06 to 15.77; *P*=.98). Measured according to the Mini Mental State Examination (MMSE), delirium was reported in 1 RCT[39] which compared spinal anesthesia

with general anesthesia. No significant differences were found between the 2 groups, and the evidence was insufficient to make firm conclusions regarding the comparative efficacy of these interventions on delirium incidence.

In a meta-analysis of 4 RCTs,[20,21,84,85] a significant difference was found favoring nerve blocks over no nerve blocks for the occurrence of delirium (11/242 vs 33/219; OR = 0.33; 95 percent CI = 0.16 to 0.66; *P*=.002). A pooled analysis of 2 cohort studies[83,86] similarly demonstrated a lower occurrence of delirium for nerve blocks compared with no nerve block (11/227 vs 55/407; OR = 0.24; 95 percent CI = 0.08 to 0.72; *P*=.01). The strength of evidence for these results was rated as moderate.

Additional Pain Medication Use

Pooled results from 7 RCTs[15,17,26,28,29,84,87] reporting the use of additional pain medications in a total of 378 participants found a significant difference associated with nerve blocks compared with no nerve block (49/197 vs 68/181; OR = 0.32; 95 percent CI = 0.14 to 0.72; *P*=.0006). Similarly, a retrospective cohort study[86] also reported a statistically significant difference in favor of nerve blocks (0/49 vs 14/50; OR = 0.03; 95 percent CI = 0.00 to 0.44; *P*=.01). In 1 RCT[80] comparing relaxation with sham control, additional pain medication (meperidine (mg) or morphine (mg)) was needed less in the relaxation group (MD = -8.43; 95 percent CI = -15.11 to -1.75; *P*=.01).

Length of Stay (LOS) for Acute Hospitalization

In 2 RCTs[43,82] comparing spinal anesthesia with general anesthesia, the LOS was significantly less for the general anesthesia group (MD = 1.69; 95 percent CI = 0.38 to 3.01; *P*=.01). Two retrospective cohort studies reported the LOS for acute hospitalization associated with nerve blocks.[23,86,83] Pooled results were not provided due to substantial heterogeneity between the studies; however, both the 3-in-1 nerve block[86] and the femoral nerve block[65] showed lower LOS compared to placebo, with an even more favorable result for the 3-in-1 nerve block.

Adverse Events Relating to Pain Medications for Hip Fracture

Overall, the studies were not sufficiently powered to determine differences in adverse effects between treatment groups. Furthermore, few studies reported serious adverse events including myocardial infarction, stroke, and renal failure.

Deep Venous Thrombosis and Pulmonary Embolism

Reported in 2 RCTs[17,89] including 100 patients, no significant differences with respect to the occurrence of deep venous thrombosis were noted between patients receiving nerve block compared with placebo groups. Another 2 RCTs[19,84] reporting pulmonary embolism in 128 subjects also found no significant difference between the nerve block group compared with placebo.

Myocardial Infarction and Stroke

Myocardial infarction, a serious adverse event, was reported infrequently throughout the literature. Two RCTs which included 145 total participants[19,23] reported no significant differences in the occurrence of myocardial infarction among patients receiving nerve block compared with those receiving placebo (1/72 vs 1/73; OR = 1.00; 95 percent CI = 0.06 to 16.67; *P*=1.00). Likewise, another retrospective cohort study[83] of 535 subjects comparing nerve blocks to placebo also found no significant differences between the 2 groups.

In 1 RCT[89] no significant difference in strokes was reported among patients receiving nerve blocks comparing with placebo (2/64 vs. 1/64; OR 1.63; 95 percent CI = 0.19 to13.61; *P*=.65) Another retrospective cohort study[83] of 535 subjects also found no statistically significant difference between these 2 groups.

Hypotension

Larger doses of spinal anesthetic resulted in more hypotension issues without improvements in pain control.[90] Hypotension was reported in 3 cohort studies of 267 participants.[57,58,60] A statistically significant reduction in hypotension was associated with 2.5 mg of bupivacaine compared to 5 mg of the medication (15/121 vs 21/161; OR = 0.08; 95 percent CI = 0.03 to 0.23; *P*<.00001). Likewise, a reduction in hypotension was found for 4 mg compared to 12 mg of bupivacaine (3/30 vs 23/30; OR = 0.03; 95 percent CI = 0.01 to 0.15) and for 0.125 percent vs 0.5 percent bupivacaine (4/12 vs 10/13; OR = 0.15; 95 percent CI = 0.03 to 0.87; *P*=.03. In 3 RCTs of 132 subjects[46,53,91] a significantly lower incidence of hypotension was reported in patients receiving sufentanil compared to no sufentanil (8/66 vs 45/66; OR = 0.05; 95 percent CI = 0.01 to 0.34; *P*=.002).

Respiratory infection

No significant differences were found between groups in 5 RCTs[17,19,84,89,92] reporting respiratory infection for nerve blocks compared with placebo. However, 1 retrospective cohort study[83] found a significant difference between the 2 groups in favor of nerve blocks (9/178 vs 39/357; OR = 0.43; 95 percent CI = 0.21 to 0.92; *P*=.03).

Subpopulation Analyses

Subpopulation characteristics including sex, age, race, marital status, comorbidities, body mass index (BMI), pre-fracture functional status, and family distress were analyzed. The evidence for this key question was lacking or insufficient to draw conclusions regarding the effectiveness and safety of pain management interventions for these prespecified subpopulations.

Patients with pre-existing heart disease were recruited in 1 study[19] which found a significant reduction in acute pain favoring nerve blocks compared with no nerve block (MD = -0.98; 95 percent CI = -1.49 to -0.48; *P*<.0001). No significant differences were found for 30-day mortality, or adverse events including cardiac complications, congestive heart failure, myocardial infarction, respiratory infection, or pulmonary embolism.

Participants who were independent prior to hip fracture were recruited in 1 RCT[84] which found no significant difference between nerve blocks compared with standard care for 30-day mortality. Another trial[77] conducted among Asian patients found no difference in acute pain reduction for skin traction compared with placebo.

Limitations of the Review

Despite the extensive research process that was incorporated to gather the existing evidence on pain management interventions for older patients with hip fractures, there were limitations that hindered the ability to draw firm conclusions. Evidence on the comparative effectiveness of pain management interventions was hampered by a lack of standardized evidence-based guidelines for assessing pain specific older patients with a large number of comorbidities. In addition, a stratified analysis of subpopulations within the hip fracture patient population was rarely found. Broad cognitive assessment tools including the Mini-Mental State Examination were used to differentiate between dementia onset and acute delirium. Although coexisting conditions were frequently present in the hip fracture patient population, risk adjustments used in various studies were not reported. Pre-fracture functional status, an important component which can potentially impact reported pain levels, was rarely reported.

The studies included in this comprehensive review contained small sample sizes and reported a limited number of outcome measures. While several of the studies had poor methodology, there was also a high risk of bias. The strength of evidence was low or insufficient for most outcomes. The effects of long-term pain were not studied. Over half of the studies excluded patients with cognitive impairment, an important subpopulation of interest. The included studies did not exclusively examine patients from institutional settings, which further impaired the external validity or applicability of the findings.

Although the studies included in the review consisted primarily of pharmacologic therapies and mainly focused on the discipline of anesthesiology, additional evidence has shown the benefits of multidisciplinary therapeutic interventions for the attainment of optimal pain management.[93,94] Other limitations include the narrow scope of regions in which the studies were conducted. Focusing mostly on single centers in Europe and Asia, minimal evidence on the comparative effectiveness of pain interventions was identified in North America. The search was limited to 1990, which leaves little to conclude about early research and studies for the treatment of pain.

The review presented valid evidence for the reduction of acute pain and delirium with nerve block interventions. However, most of the studies lacked sufficient power to truly detect the differences in adverse effects between treatment groups. In addition, few studies reported serious adverse events including myocardial infarction, stroke, and renal failure. Another limitation was the lack of comparisons for CAM approaches with pharmacological treatments.

The studies identified a reduced need for systemic analgesics. Nonetheless, the clinical significance of this finding is only beneficial if the reduced requirement for systemic analgesics can be associated with a reduction in adverse events. Little evidence exists on the long-term effects of early postoperative pain management, and the management of pain following hospital discharge. Most studies also failed to note whether or not the patients had any negative or positive effects from the intervention which would compromise their ability to mobilize postoperatively.

Directions for Future Research

There is a strong need for larger sample sizes and multicenter studies to address the long-term benefits and adverse events associated with improved pain management. Future studies should also address the effects of pain management interventions on older patients with dementia. Subpopulations of interest should be reviewed in order to determine effects of interventions on factors such as race, gender, age, or other existing comorbidities. The additive benefits of pharmacological interventions with nonpharmacological interventions including rehabilitation

and CAM should be researched. The effects of multimodal pain management should be identified in order to determine if there are additional benefits from the incorporation of a multidisciplinary approach.

More simplified and clinically meaningful conclusions regarding the comparative effectiveness of different pain interventions for patients with hip fractures can be reached through the standardization of outcomes and outcome measures. The multidimensional nature of pain is not reflected in the measured outcomes. Validated pain scores, prescribed opioids and other pharmacologic therapies, adverse effects, and complications attributable to the intervention are all relevant outcomes for future study. Other outcomes including functional pain, quality of life, and recovery time should be researched. Pain assessment scales, which can be used to assess pain in patients that cannot communicate verbally such as patients with delirium or dementia, would also be valuable for future research studies. A significant issue with determining the level of pain for the hip fracture patient is not only the subjective nature of pain, but also the fact that patients may have confusion or dementia inhibiting their ability to convey the degree to which they are suffering. These communication issues can be addressed through other pain assessment tools that use a nonverbal component. In order to effectively determine the efficacy of various interventions for reducing pain intensity, pain assessments should be conducted preoperatively and daily among hospitalized patients. Regular long-term followup is crucial to determine the patient's pain status after discharge from the hospital. Pain outcomes evaluated over the 6 months following the fracture can be used to effectively determine the most appropriate intervention which will ultimately result in complete recovery for the patient.

Patients with cognitive impairments, including dementia and delirium, are important for future studies as they represent a large fraction of the population affected by hip fractures. Cognitive screening tools could be used to differentiate between acute or chronic delirium in patients with underlying or newly onset dementia. Overall, the standardization of outcome measures and assessment tools to measure pain will minimize bias, which will also provide a more validated approach to determining the most effective strategy to reduce pain in the hip fracture patient.

Conclusions

The sparsity of data available on pain management interventions for hip fractures hinders the ability to make firm conclusions regarding the efficacy of a single approach compared with other approaches for treating hip fracture-related pain. The evidence shows improvements in short-term pain scores for most interventions, but fails to reflect the long-term outcomes, which are important in terms of cost, morbidity, and quality of life. Complication rates were low overall, and adverse events were not significantly different among the interventions studied. High-quality designed trials with a large number of subjects are needed to truly determine the comparative effectiveness of the interventions.

The available evidence from the review identifies the effectiveness of nerve blocks for improved pain relief compared with standard care alone. Furthermore, nerve blocks have the ability to reduce the need for additional systemic analgesia, and may reduce the risk of delirium. Overall, most nerve blocks were able to reduce the intensity of acute pain and the incidence of delirium. Although most practicing anesthesiologists incorporate nerve blocks in treatment, the time, effort, and supervision required to ensure that they work well has deterred many institutions from using them. A low strength of evidence showed that nerve blocks do not reduce the risk of 30-day mortality; however, the results from studies were not sufficiently powered to fully determine the effects on mortality outcomes.

The review indicated a potential for pain relief with rehabilitation, acupressure, relaxation therapy, and TENS, but the evidence was insufficient to draw firm conclusions. Spinal anesthesia, used during surgery, did not differ in mortality rates, delirium, or other medical complications of the fracture compared with general anesthesia. Furthermore, the addition of other agents to plain local anesthetic for spinal anesthesia did not make any difference in the outcomes outside of the operating room. Larger doses of spinal anesthesia may induce hypotension, without improvements in pain relief.[90]

Overall, the evidence points to improvements in short-term pain scores for most interventions. The complication rates were generally low and did not differ significantly between interventions. Improvements in the design of trials and larger sample sizes with a greater degree of statistical power will allow for conclusions to be made regarding the comparative effectiveness of various interventions intended to reduce pain following a hip fracture. Until future research is conducted, the management of pain in patients affected by hip fractures is dependent on the available evidence from interventions, staff skills, and an understanding of pre-existing patient comorbidities.

The comprehensive review conducted by the AHRQ on pain management interventions for hip fractures presents the available evidence intended to guide clinicians in making shared and informed decisions for patients suffering from hip fractures. Health care professionals are faced with the challenge of determining how to ultimately treat the pain in an effort to achieve the most optimal outcome. Effective pain management has the potential to reduce the risk for pulmonary embolism and deep venous thrombosis, in addition to reducing the incidence of delirium and the length of hospitalization. A challenge for health care providers is determining the patient's pain levels. With many affected individuals already experiencing dementia and cognitive impairment, the ability to adequately assess the pain can be difficult. Validated measures and scales are necessary. Several studies found statistically significant differences in pain reported according to the *P*-value, but these findings were not clinically significant. Studies in various populations have shown that a meaningful change in pain scores corresponds to at least a 0.9 to 1.3 cm reduction on the 10 cm VAS. In other words, a statistically significant reduction in acute pain may no be deemed clinically significant enough to allow for improvements in the patient's self-reported pain level and functional status.

Current research generally suggests that effective pain management will improve outcomes for older patients who are hospitalized after hip fractures. The evidence indicates that well-managed pain will allow patients more comfort and mobility, shorter length of hospitalizations, reduced delirium, and an enhanced quality of life. The AHRQ systematic review indicates that most nerve blocks, especially femoral and fascia iliaca blocks, are effective for significantly reducing pain intensity in these patients. However, research on the comparative benefits and risks of pain management interventions for hip fracture patients is still in its infancy. In addition to the overall question of which interventions are most effective, clinicians need to know:

- Whether nerve blocks are more efficacious and associated with fewer side effects and better outcomes than standard opioid therapies
- Whether certain subpopulations will benefit more from nerve blocks or standard opioid therapy
- Whether there are differences between opioid agents in terms of efficacy, side effect profiles, and other outcomes
- What roles nonpharmacologic approaches might play in combination treatments

References

1. Brainsky A, Glick H, Lydick E, et al. The economic cost of hip fractures in community-dwelling older adults: a prospective study. *J Am Geriatr Soc.* 1997;45(3):281-87.

2. Cooper C, Campion G, Melton LJ, III. Hip fractures in the elderly: a world-wide projection. *Osteoporos Int.* 1992;2(6):285-89.

3. Gullberg B, Johnell O, Kanis JA. World-wide projections for hip fracture. *Osteoporos Int.* 1997;7(5):407-13.

4. Maggi S, Kelsey JL, Litvak J, et al. Incidence of hip fractures in the elderly: a cross-national analysis. *Osteoporos Int.* 1991;1(4):232-41.

5. American Geriatrics Society. The management of chronic pain in older persons: AGS panel on chronic pain in older persons: American geriatrics society. *J Am Geriatr Soc.* 1998;46(5):631-51.

6. Cleeland CS. Undertreatment of cancer pain in elderly patients. *JAMA.* 1998;279(23):1914-15.

7. Ferrell BA. Pain management in elderly people. *J Am Geriatr Soc.* 1991;39(1):64-73.

8. Nussenzveig TC. Pain management after total joint replacement and its impact on patient outcomes. *AORN J.* 1999;70(6):1060-62.

9. Abou-Setta AM, Beaupre LA, Jones CA, Rashiq S. Pain Management Interventions for Hip Fracture. Comparative Effectiveness Review No. 30. Rockville, MD. Agency for Healthcare Research and Quality. 2011.

10. Owens DK, Lohr KN, Atkins D, et al. Grading the Strength of a Body of Evidence When Comparing Medical Interventions. 2008.

11. Milisen K, Abraham IL, Broos PL. Postoperative variation in neurocognitive and functional status in elderly hip fracture patients. *J Adv Nurs.* 1998;27(1):59-67.

12. Goldstein FC, Strasser DC, Woodard JL, et al. Functional outcome of cognitively impaired hip fracture patients on a geriatric rehabilitation unit. *J Am Geriatr Soc.* 1997;45(1):35-42.

13. Francis J. Delirium in older patients. *J Am Geriatr Soc.* 1992;40(8):829-38.

14. Williams MA, Campbell EB, Raynor WJ, et al. Reducing acute confusional states in elderly patients with hip fractures. *Res Nurs Health.* 1985;8(4):329-37.

15. Chudinov A, Berkenstadt H, Salai M, et al. Continuous psoas compartment block for anesthesia and perioperative analgesia in patients with hip fractures. *Reg Anesth Pain Med.* 1999;24(6):563-68.

16. Cuvillon P, Ripart J, Debureaux S, et al. [Analgesia after hip fracture repair in elderly patients: the effect of a continuous femoral nerve block: a prospective and randomised study]. *Ann Fr Anesth Reanim.* 2007;26(1):2-9.

17. Fletcher AK, Rigby AS, Heyes FL. Three-in-one femoral nerve block as analgesia for fractured neck of femur in the emergency department: a randomized, controlled trial. *Ann Emerg Med.* 2003;41(2):227-33.

18. Haddad FS, Williams RL. Femoral nerve block in extracapsular femoral neck fractures. *J Bone Joint Surg Br.* 1995;77(6):922-23.

19. Matot I, Oppenheim-Eden A, Ratrot R, et al. Preoperative cardiac events in elderly patients with hip fracture randomized to epidural or conventional analgesia. *Anesthesiology.* 2003;98(1):156-63.

20. Mouzopoulos G, Vasiliadis G, Lasanianos N, et al. Fascia iliaca block prophylaxis for hip fracture patients at risk for delirium: a randomized placebo-controlled study. *J Orthop Traumatol.* 2009;10(3):127-33.

21. Monzon DG, Vazquez J, Jauregui JR, et al. Pain treatment in post-traumatic hip fracture in the elderly: regional block vs. systemic non-steroidal analgesics. *Int J Emerg Med.* 2010;3(4):321-25.

22. Murgue D, Ehret B, Massacrier-Imbert S, et al. Equimolar nitrous oxide/oxygen combined with femoral nerve block for emergency analgesia of femoral neck fractures. *J Eur Urg.* 2006;19(1):9-14.

23. Scheinin H, Virtanen T, Kentala E, et al. Epidural infusion of bupivacaine and fentanyl reduces perioperative myocardial ischaemia in elderly patients with hip fracture--a randomized controlled trial. *Acta Anaesthesiol Scand.* 2000;44(9):1061-70.

24. Segado J, Bayon G, Arias D, et al. [Efficacy of obturator and femoral cutaneous nerve blocks for postoperative analgesia in hip surgery]. *Rev Esp Anestesiol Reanim.* 2009;56(10):590-97.

25. Segado J, Arias D, Casas Garca M, et al. Post-surgical analgesia in hip surgery: a comparison of three techniques. *Rev Soc Esp Dolor.* 2010;17(6):259-67.

26. Tuncer S, Sert O, Yosunkaya A, et al. Patient-controlled femoral nerve analgesia versus patient-controlled intravenous analgesia for postoperative analgesia after trochanteric fracture repair. *Acute Pain.* 2003;4(3-4):105-08.

27. Henderson K, Akhtar S, Sandoval M, et al. Femoral nerve block for pain management of hip fractures in the emergency department: preliminary results of a randomized, controlled trial [abstract]. *Ann Emerg Med.* 2012;52(4):S164.

28. Hood G, Edbrooke DL, Gerrish SP. Postoperative analgesia after triple nerve block for fractured neck of femur. *Anaesthesia.* 1991;46(2):138-40.

29. Gille J, Gille M, Gahr R, et al. [Acute pain management in proximal femoral fractures: femoral nerve block (catheter technique) vs. systemic pain therapy using a clinic internal organisation model]. *Anaesthesist.* 2006;55(4):414-22.

30. de V, V, Picart F, Le JR, et al. Combined lumbar and sacral plexus block compared with plain bupivacaine spinal anesthesia for hip fractures in the elderly. *Reg Anesth Pain Med.* 2000;25(2):158-62.

31. Eyrolle L. Regional anaesthesia for femoral neck fracture surgery: comparison of lumbar plexus block and spinal anaesthesia [abstract]. *Br J Anaesth.* 1998;80(Supple1):112.

32. Apostolopoulos A. Parecoxib as a post surgical analgesic drug in fractures of the hip joint in comparison with diclofenac-pethidine. *J Bone Joint Surg Br.* 2006;88-B(Suppl 1):186.

33. Baker A, Klimscha W, Eisenach JC, et al. Intrathecal clonidine for postoperative analgesia in elderly patients: the influence of baricity on hemodynamic and analgesic effects. *Anesth Analg.* 2004;99(1):128-34.

34. Poitevin L, Pellegrini H, Alvarez C, et al. Preoperative control in patients with femoral fractures. *Prensa Med Argent.* 1999;86(9):913-19.

35. Adams HA, Wolf C, Michaelis G, et al. Postoperative course and endocrine stress reaction of geriatric patients with para-articular hip fractures. Prospective randomized study comparing spinal anesthesia and halothane intubation narcosis. *Anasth Intensivther Notfallmed.* 1990;25(4):263-70.

36. Alonso CA, Cruz PP, Alvarez GJ, et al. Comparison of the hemodynamic response in subarachnoid anesthesia with bupivacaine versus bupivacaine with fentanyl in traumatology surgery in elderly patients. *Rev Esp Anestesiol Reanim.* 2003;50(1):17-22.

37. Ben-David B, Frankel R, Arzumonov T, et al. Minidose bupivacaine-fentanyl spinal anesthesia for surgical repair of hip fracture in the aged. *Anesthesiology.* 2000;92(1):6-10.

38. Bredahl C, Hindsholm KB, Frandsen PC. Changes in body heat during hip fracture surgery: a comparison of spinal analgesia and general anaesthesia. *Acta Anaesthesiol Scand.* 1991;35(6):548-52.

39. Casati A, Aldegheri G, Vinciguerra E, et al. Randomized comparison between sevoflurane anaesthesia and unilateral spinal anaesthesia in elderly patients undergoing orthopaedic surgery. *Eur J Anaesthesiol.* 2003;20(8):640-46.

40. Danelli G, Baciarello M, Di CS, et al. Effects of baricity of 0.5 percent or 0.75 percent levobupivacaine on the onset time of spinal anesthesia: a randomized trial. *Can J Anaesth.* 2008;55(8):501-06.

41. Favarel-Garrigues JF, Sztark F, Petitjean ME, et al. Hemodynamic effects of spinal anesthesia in the elderly: single dose versus titration through a catheter. *Anesth Analg.* 1996;82(2):312-16.

42. Hooda S, Malhotra N, Kumar L. Evaluation of three doses of intrathecal bupivacaine with fentanyl in geriatric patients undergoing hip surgery. *J Anaesth Clin Phamacol.* 2006;22(3):267-72.

43. Juelsgaard P, Sand NP, Felsby S, et al. Perioperative myocardial ischaemia in patients undergoing surgery for fractured hip randomized to incremental spinal, single-dose spinal or general anaesthesia. *Eur J Anaesthesiol.* 1998;15(6):656-63.

44. Klimscha W, Chiari A, Krafft P, et al. Hemodynamic and analgesic effects of clonidine added repetitively to continuous epidural and spinal blocks. *Anesth Analg.* 1995;80(2):322-27.

45. Kwan AS, Lee BB, Brake T. Intrathecal morphine for post-operative analgesia in patients with fractured hips. *Hong Kong Med J.* 1997;3(3):250-55.

46. Malek J, Kurzova A. Intrathecal fentanyl and sufentanil added to bupivacaine augments analgesia after surgical repair of hip fracture. *Acute Pain.* 2004;6(2):53-56.

47. Martyr JW, Clark MX. Hypotension in elderly patients undergoing spinal anaesthesia for repair of fractured neck of femur. A comparison of two different spinal solutions. *Anaesth Intensive Care.* 2001;29(5):501-05.

48. Maurette P, Bonada G, Djiane V, et al. A comparison between lidocaine alone and lidocaine with meperidine for continuous spinal anesthesia. *Reg Anesth.* 1993;18(5):290-95.

49. Minville V, Fourcade O, Grousset D, et al. Spinal anesthesia using single injection small-dose bupivacaine versus continuous catheter injection techniques for surgical repair of hip fracture in elderly patients. *Anesth Analg.* 2006;102(5):1559-63.

50. Navas Martinez A, Ortiz de la Tabla Gonzalez R, Vazquez Gutierrz T, et al. Continuous subarachnoid blockade versus single shot technique for surgical treatment of the hip fracture [abstract]. *Reg Anesth Pain Med.* 2008;33(5 Suppl 1):e30.

51. Olofsson C, Nygards EB, Bjersten AB, et al. Low-dose bupivacaine with sufentanil prevents hypotension after spinal anesthesia for hip repair in elderly patients. *Acta Anaesthesiol Scand.* 2004;48(10):1240-44.

52. Rais K, Jajjej Z, Rami O, et al. Comparative study of two doses of bupivacaine for continuous spinal anesthesia in elderly.European Society of Anesthesiology 2008.

53. Said-Ahmed HAE. Comparison of hypotension after spinal anesthesia in the elderly with either bupivacaine minidose plus fentanyl/sufentanil or bupivacaine conventional dose. *Acta Anaesthesiol Ital.* 2006;57(2-3):198-203.

54. Resch S, Thorngren K. Preoperative skin vs. skeletal traction in patients with hip fractures: the effect on pain and on patient flow characteristics [abstract]. *Acta Orthop Scand Suppl.* 1996;(270):34-35.

55. Krobot R, Premuzic J, Bacak I. Levobupivacaine-fentanyl spinal anaesthesia for hip fracture repair in the elderly [abstract]. *Reg Anesth Pain Med.* 2006;31(5 Suppl 1):33.

56. Koval K, Premuzic J, Bacak I. Hip fracture in the elderly: the effect of anesthetic technique. *Orthopedics.* 1999;22(1):31-34.

57. Labaille T, Benhamou D, Westermann J. Hemodynamic effects of continuous spinal anesthesia: a comparative study between low and high doses of bupivacaine. *Reg Anesth.* 1992;17(4):193-96.

58. Malcolmson S, Freebairn R. Haemodynamic stability and vasopressor use during low-dose spinal anesthesia as a risk factor in the femoral fracture near the hip joint in elderly patients. *Critical Care and Shock.* 2009;12(4):144-56.

59. Miller K, Reichel M, Karlbauer R, et al. [The choice of the method of anesthesia as a risk factor in the femoral fracture near the hip joint in elderly patients]. *Anaesthesist.* 1990;39(2):83-87.

60. Minville V, Asehnoune K, Delussy A, et al. Hypotension during surgery for femoral neck fracture in elderly patients: effect of anaesthetic techniques. A retrospective study. *Minerva Anestesiol.* 2008;74(12):691-96.

61. Sen S, Aydin K, Discigil G. Hypotension induced by lateral decubitus or supine spinal anaesthesia in elderly with low ejection fraction undergone hip surgery. *J Clin Monit Comput.* 2007;21(2):103-07.

62. Sutcliffe AJ, Parker M. Mortality after spinal and general anaesthesia for surgical fixation of hip fractures. *Anaesthesia.* 1994;49(3):237-40.

63. Shih Y, Hsieh C, Kang T, et al. General versus spinal anesthesia: which is a risk factor for octogenarian hip fracture repair patients? *Int J Gerontol.* 2010;4(1):37-42.

64. Martyr JW, Stannard KJ, Gillespie G. Spinal-induced hypotension in elderly patients with hip fracture. A comparison of glucose-free bupivacaine with glucose-free bupivacaine and fentanyl. *Anaesth Intensive Care.* 2005;33(1):64-68.

65. Poitras S, Brosseau L. Evidence-informed management of chronic low back pain with transcutaneous electrical nerve stimulation, interferential current, electrical muscle stimulation, ultrasound, and thermotherapy. *Spine J.* 2008;8(1):226-33.

66. Gorodetskyi IG, Gorodnichenko AI, Tursin PS, et al. Non-invasive interactive neurostimulation in the post-operative recovery of patients with a trochanteric fracture of the femur. A randomised, controlled trial. *J Bone Joint Surg Br.* 2007;89(11):1488-94.

67. Lang T, Barker R, Steinlechner B, et al. TENS relieves acute posttraumatic hip pain during emergency transport. *J Trauma.* 2007;62(1):184-88.

68. Parker MJ, Handoll HH. Pre-operative traction for fractures of the proximal femur in adults. *Cochrane Database Syst Rev.* 2006;3:CD000168.

69. Burke A, Emer S, FitzGerald G. *Analgesic, antipyretic and anti-inflammatory agents; pharmacotherapy of Goa. In: Brunton LL, Lazo JS, Parker KL, eds. Goodman & Gilman's The Pharmacological Basis of Therapeutics.* 11 ed. ed. The McGraw-Hill Companies; 2006.

70. Resch S, Bjarnetoft B, Thorngren KG. Preoperative skin traction or pillow nursing in hip fractures: a prospective, randomized study in 123 patients. *Disabil Rehabil.* 2005;27(18-19):1191-95.

71. Jerre R, Doshe A, Karlsson J. Preoperative skin traction in patients with hip fractures is not useful. *Clin Orthop Relat Res.* 2000;(378):169-73.

72. Needoff M, Radford P, Langstaff R. Preoperative traction for hip fractures in the elderly: a clinical trial. *Injury.* 1993;24(5):317-18.

73. Rosen JE, Chen FS, Hiebert R, et al. Efficacy of preoperative skin traction in hip fracture patients: a prospective, randomized study. *J Orthop Trauma.* 2001;15(2):81-85.

74. Anderson GH, Harper WM, Connolly CD, et al. Preoperative skin traction for fractures of the proximal femur. A randomised prospective trial. *J Bone Joint Surg Br.* 1993;75(5):794-96.

75. Ghnaimat M, Aldweri M, Hijazi A, et al. Preoperative skin traction for fractures fo the proximal femur. *J Bahrain Med Soc.* 2005;17(4):240-42.

76. Saygi B, Ozkan K, Eceviz E, et al. Skin traction and placebo effect in the preoperative pain control of patients with collum and intertrochanteric femur fractures. *Bull NYU Hosp Jt Dis.* 2010;68(1):15-17.

77. Yip DK, Chan CF, Chiu PK, et al. Why are we still using pre-operative skin traction for hip fractures? *Int Orthop.* 2002;26(6):361-64.

78. Di LL, Forte A, Formisano R, et al. Low back pain after unstable extracapsular hip fractures: randomized control trial on a specific training. *Eura Medicophys.* 2007;43(3):349-57.

79. Fassoulaki A, Paraskeva A, Kostopanagiotou G, et al. Acupressure on the extra 1 acupoint: the effect on bispectral index, serum melatonin, plasma beta-endorphin, and stress. *Anesth Analg.* 2007;104(2):312-17.

80. Martin K. Relaxation as a postoperative comfort measure in elderly patients with fractured hips [dissertation]. Louisville, KY: Bellarmine College; 1991.

81. Barker R, Kober A, Hoerauf K, et al. Out-of-hospital auricular acupressure in elder patients with hip fracture: a randomized double-blinded trial. *Acad Emerg Med.* 2006;13(1):19-23.

82. Adams HA, Wolf C, Michaelis G, et al. [Postoperative course and endocrine stress reaction of geriatric patients with para-articular hip fractures. Prospective randomized study comparing spinal anesthesia and halothane intubation narcosis]. *Anasth Intensivther Notfallmed.* 1990;25(4):263-70.

83. Pedersen SJ, Borgbjerg FM, Schousboe B, et al. A comprehensive hip fracture program reduces complication rates and mortality. *J Am Geriatr Soc.* 2008;56(10):1831-38.

84. Foss NB, Kristensen MT, Kristensen BB, et al. Effect of postoperative epidural analgesia on rehabilitation and pain after hip fracture surgery: a randomized, double-blind, placebo-controlled trial. *Anesthesiology.* 2005;102(6):1197-204.

85. Graham C, Baird K, McGuffie A. A pilot randomised clinical trial of 3-in- femoral nerve block and intravenous morphine as primary analgesia for patients presenting to the emergency department with fractured hip. *Hong Kong J Emerg Med.* 2008;15(4):205-11.

86. Del Rosario E, Esteve N, Sernandez M, et al. Does femoral nerve analgesia impact the development of postoperative delirium in the elderly?:a retrospective investigation. *Acute Pain.* 2008;10(2):59-64.

87. Coad NR. Post-operative analgesia following femoral-neck surgery--a comparison between 3 in 1 femoral nerve block and lateral cutaneous nerve block. *Eur J Anaesthesiol.* 1991;8(4):287-90.

88. Hood G, Edbrooke DL, Gerrish SP. Postoperative analgesia after triple nerve block for fractured neck of femur. *Anaesthesia.* 1991;46(2):138-40.

89. Haddad FS, Williams RL. Femoral nerve block in extracapsular femoral neck fractures. *J Bone Joint Surg Br.* 1995;77(6):922-23.

90. Roofthooft E, Van d, V. Low-dose spinal anaesthesia for Caesarean section to prevent spinal-induced hypotension. *Curr Opin Anaesthesiol.* 2008;21(3):259-62.

91. Qamarul H. Efficacy and hemodynamic effects of three different dosages of bupivacaine with fentanyl in spinal anaesthesia for surgical repair of hip fracture [abstract]. *Reg Anesth Pain Med.* 2003;28(Suppl 1):6.

92. Yun MJ, Kim YH, Han MK, et al. Analgesia before a spinal block for femoral neck fracture: fascia iliaca compartment block. *Acta Anaesthesiol Scand.* 2009;53(10):1282-87.

93. Malchow RJ, Black IH. The evolution of pain management in the critically ill trauma patient: Emerging concepts from the global war on terrorism. *Crit Care Med.* 2008;36(7 Suppl):S346-S357.

94. Pergolizzi J, Boger RH, Budd K, et al. Opioids and the management of chronic severe pain in the elderly: consensus statement of an International Expert Panel with focus on the six clinically most often used World Health Organization Step III opioids (buprenorphine, fentanyl, hydromorphone, methadone, morphine, oxycodone). *Pain Pract.* 2008;8(4):287-313.

Method of participation:

CE credit awards require completion of the entire program and of learner assessment tools, after which the learner can print a certificate of completion.

Instructions to obtain credit:

1. Complete the activity in its entirety.
2. Access the credit center online: **www.ce.effectivehealthcare.ahrq.gov/credit**
3. Enter program code: **CER27**
4. Complete the post-test and evaluation online
5. Upon completion of the learner assessment tools, you will be able to print your certificate.

Accreditation Statements:

Physician Credit Designation Statement

PRIME Education, Inc. (PRIME®) is accredited by the Accreditation Council for Continuing Medical Education to provide continuing medical education for physicians.

PRIME® designates this enduring material for a maximum of 1.0 *AMA PRA Category 1 Credit*™. Physicians should claim only credit commensurate with the extent of their participation in the activity.

Physician Assistant Accreditation Statement

AAPA accepts AMA Category 1 CME Credit™ for the PRA from organizations accredited by ACCME.

Nurse Practitioner Accreditation Statement

PRIME Education, Inc. (PRIME®) is accredited by the American Academy of Nurse Practitioners as an approved provider of nurse practitioner continuing education. Provider number: 060815. This program is accredited for 1.0 contact hour. Program ID# CER27.

This program was planned in accordance with AANP CE Standards and Policies and AANP Commercial Support Standards.

Pharmacist Accreditation Statement

This curriculum has been approved for 1.0 contact hour by PRIME®. PRIME® is accredited by the Accreditation Council for Pharmacy Education as a provider of continuing pharmacy education. The Universal Activity Number for this program is 0255-0000-12-012-H01-P. This learning activity is **Knowledge-based**.

Nurse Accreditation Statement

PRIME Education, Inc. (PRIME®) is accredited as a provider of continuing nursing education by the American Nurses Credentialing Center's Commission on Accreditation. PRIME® designates this activity for 1.0 contact hour.

Case Manager Accreditation Statement

The Commission for Case Manager Certification designates this educational activity for 1.0 contact hour for certified case managers.

Certified Health Education Specialist Accreditation Statement

Sponsored by PRIME Education, Inc. (PRIME®), a designated provider of continuing education contact hours (CECH) in health education by the National Commission for Health Education Credentialing, Inc.

This program is designated for Certified Health Education Specialists (CHES) to receive up to 1.0 Category I contact hours in health education.

CHES Provider Number: MEP3774

Release Date: March 31, 2012 Expiration Date: March 31, 2014

There is no fee for this CME/CE activity. This activity is sponsored by PRIME Education, Inc (PRIME®) and funded under contract HHSA290201000006G from the Agency for Healthcare Research and Quality (AHRQ), U.S. Department of Health and Human Services (HHS).